UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555

December 18, 1992

NRC INFORMATION NOTICE 88-23, SUPPLEMENT 4: POTENTIAL FOR GAS BINDING OF HIGH-PRESSURE SAFETY INJECTION PUMPS DURING A DESIGN BASIS ACCIDENT

Addressees

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice supplement to alert addressees to problems that could result from the transport and accumulation of gases in the piping of emergency core cooling systems. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Background

Each unit at the Surry Power Station has two low head safety injection (LHSI) pumps which, during a design basis event, are initially aligned to take suction from the refueling water storage tank (RWST) and to discharge into cold legs of the reactor coolant system (RCS). When a low level in the RWST is reached, the LHSI pumps would automatically be realigned to take suction from the containment sump and discharge to the high head safety injection (HHSI) pumps ("piggyback" mode) through the recirculation mode transfer (RMT) piping. Two check valves in series are located in each of the three LHSI pump discharge lines to the RCS cold legs. These check valves are the pressure boundary between the high pressure RCS and the low pressure LHSI system during normal power operation. Attachment 1 depicts the general layout for piping and components of the Surry Units 1 and 2 LHSI and HHSI systems.

Description of Circumstances

While starting the LHSI pumps at Surry Unit 2 in July 1992, Virginia Power (the licensee) observed pressure spikes, some greater than approximately 2,760 kPa (400 psig), in the LHSI piping. Upon investigating these pressure spikes, the licensee discovered gas voids in the RMT piping. Approximately 1.4 cubic meters (50 cubic feet) of gas (at standard temperature and pressure) was vented from the RMT piping. Another 0.9 cubic meters (32.5 cubic feet) of gas was vented from the LHSI pump discharge to the cold leg piping. Over the

next week an additional 0.7 cubic meters (26 cubic feet) of gas was vented from the LHSI pump discharge to the RCS cold leg piping. Attachment 1 identifies the locations from which gas was vented.

Samples of the vented gas were analyzed. The samples contained varying quantities of hydrogen, oxygen, and nitrogen.

The licensee believes that the principal source of the gas is from reactor coolant that leaked past the RCS cold leg check valves into the LHSI piping. Once the reactor coolant leaks past the check valves it depressurizes from approximately 15,400 kPa (2235 psig) to approximately 138 kPa (20 psig) and cools from approximately 282 degrees Celsius (540 degrees Fahrenheit) to various local temperatures. Gases in the reactor coolant then come out of solution and migrate to the high points of the LHSI system.

The licensee concluded that the system pressure spikes observed when starting the LHSI pumps may have resulted from collapsing steam or gas voids within the LHSI system. The licensee concluded that steam voids could be present at normal operating temperature. The licensee conducted ultrasonic testing and confirmed the presence of voids upstream of the RCS cold leg check valves in the LHSI system piping. Cold leg check valve leakage in Unit 2 is indicated by the fact that the unlagged common discharge header for the LHSI pumps was hot to the touch (approximately 49 degrees Celsius [120 degrees Fahrenheit]). In addition, leakage rates into the RWST of up to 1.13 liters per minute (0.3 gallons per minute) have been identified during normal power operation. The combined Unit 2 cold leg check valve seat leak rate measured in July 1992 was approximately 0.42 liters per minute (0.11 gallons per minute). These leakage rates are within the limits allowed by the Technical Specifications.

Upon discovery of the gas accumulation in the Unit 2 piping system, the licensee began routine venting of portions of the system that may contain gas pockets. The licensee initially vented those sections of piping several times a day until confident that rapid increase in gas accumulation was not occurring. The quantity of gas vented is recorded and trended, and the venting frequency is adjusted as necessary based on the results. This piping is currently being vented weekly. In addition, the licensee inspected and subsequently identified gas in the Unit 1 RMT piping. Comparable actions were then taken on Unit 1.

The licensee also analyzed the possible effects of the accumulated gas on the HHSI pumps for the specific circumstances identified and concluded that it would not have significantly degraded pump performance.

Discussion

To address previous concerns with gas binding of high pressure safety injection pumps, the licensee initially installed additional vents on the RMT piping near the interfaces with the HHSI and LHSI systems. The licensee also evaluated possible gas intrusion into systems other than high pressure safety injection and evaluated the effect of maintenance activities that could allow

air to enter fluid systems. However, for these actions the licensee focused on the volume control tank as being the principal source of gas. The licensee did not consider RCS leakage through check valves as a potential source of gas.

Additional discussion concerning potential gas intrusion into high-pressure safety injection pumps is contained in NRC Information Notice (IN) 88-23, IN 88-23, Supplement 1, IN 88-23, Supplement 2, and IN 88-23, Supplement 3 dated May 12, 1988, January 5, 1989, January 31, 1990, and December 10, 1990, respectively.

Additional instances of gas intrusion have been identified since the issuance of IN 88-23, Supplement 3. For example:

> TU Electric identified the presence of gas in portions of the suction piping for the centrifugal charging pumps at Comanche Peak Unit 1 in March 1991. The licensee attributed the source of the gas to hydrogen coming out of solution in the centrifugal charging pump suction header and collecting in the associated vertical piping. The licensee indicated that corrective actions to be taken to address this finding included the establishment of venting requirements. Additional discussion concerning this event is contained in Licensee Event Report (LER) 50-445/91-012 dated April 25, 1991.
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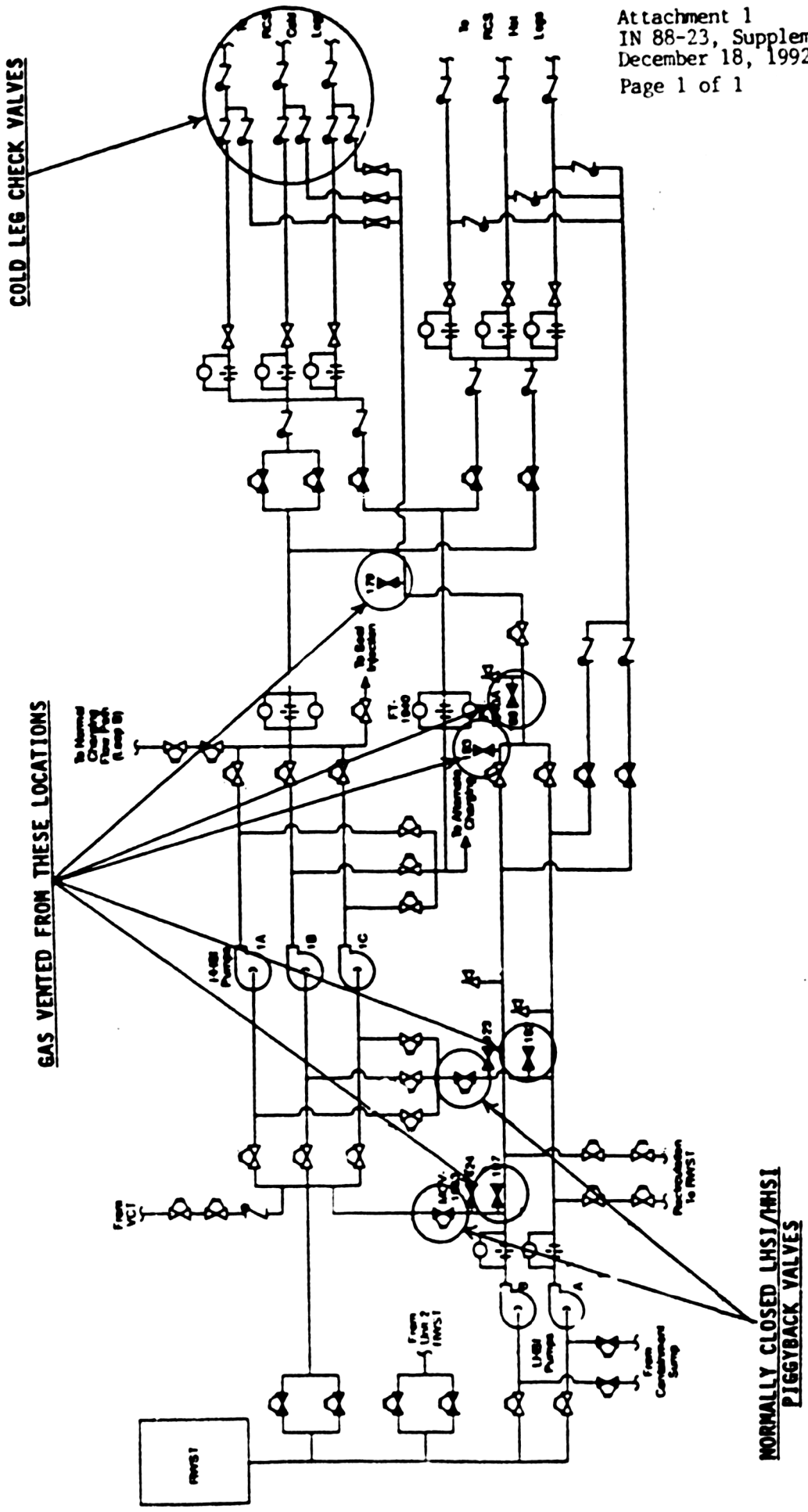
> Water hammer because of air or gas intrusion is believed to have contributed to the loss of high head safety injection function identified at Shearon Harris in April 1991. Additional discussion concerning this event is contained in IN 92-61 "Loss of High Head Safety Injection," and IN 92-61, Supplement 1, dated August 20, 1992, and November 6, 1992, respectively, and in LER 50-400/91-008-1 dated May 15, 1991.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact the technical contact listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

Brian K. Grimes, Director
Division of Operating Reactor Support
Office of Nuclear Reactor Regulation

Technical contact: S. Tingen, Region II
(804) 357-2101

Attachments:
1. Surry, Units 1 and 2 HHSI and LHSI Systems
2. List of Recently Issued NRC Information Notices


COLD LEG CHECK VALVES
GAS VENTED FROM THESE LOCATIONS
NORMALLY CLOSED LHSI/MHSI
PIGGYBACK VALVES

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
92-83	Thrust Limits for Limitorque Actuators and Potential Over-stressing of Motor-Operated Valves	12/17/92	All holders of OLs or CPs for nuclear power reactors.
92-82	Results of Thermo-Lag 330-1 Combustibility Testing	12/15/92	All holders of OLs or CPs for nuclear power reactors.
92-81	Potential Deficiency of Electrical Cables with Bonded Hypalon Jackets	12/11/92	All holders of OLs or CPs for nuclear power reactors.
92-80	Results of Thermo-Lag 330-1 Combustibility Testing	12/07/92	All holders of OLs or CPs for nuclear power reactors.
92-79	Non-Power Reactor Emergency Event Response	12/01/92	All holders of OLs or CPs for test and research reactors.
92-78	Piston to Cylinder Liner Tin Smearing on Cooper-Bessemer KSV Diesel Engines	11/30/92	All holders of OLs or CPs for nuclear power reactors.
92-77	Questionable Selection and Review to Determine Suitability of Electropneumatic Relays for Certain Applications	11/17/92	All holders of OLs or CPs for nuclear power reactors.
92-76	Issuance of Supplement 1 to NUREG-1358, "Lessons Learned from the Special Inspection Program for Emergency Operating Procedures (Conducted October 1988 - September 1991)"	11/13/92	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

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